Nuytsia The journal of the Western Australian Herbarium

24: 23–28 Published online 1 May 2014

SHORT COMMUNICATION

An amphibious *Goodenia* (Goodeniaceae) from an ephemeral arid zone wetland

In the arid zone the genus *Goodenia* Sm. is known to favour seasonally wet habitats (Sage & Pigott 2003), however only *G. lamprosperma* F.Muell and *G. nocoleche* Pellow & J.L.Porter are recorded as having an aquatic phase. Under flood conditions these species produce floating leaves on long slender petioles, which transition to a structurally different 'terrestrial' leaf form as the wetland dries (Carolin 1992; Pellow & Porter 2005). Both belong to subgen. *Goodenia* sect. *Porphyranthus* G.Don. This growth form has been termed 'amphibious fluctuation-responder' because it alters its growth pattern or morphology in response to the presence or absence of water (Brock & Casanova 1997). Amphibious arid zone wetland plants remain poorly studied largely due to the highly variable rainfall patterns across arid Australia, the limited occurrence of these habitat types, the general lack of accessibility and the short life span of these species (Pellow & Porter 2005).

In his revision of *Goodenia* for *Flora of Australia*, Carolin (1992) notes that *G. lamprosperma*, a widespread perennial herb of seasonally wet areas in northern Western Australia and the Northern Territory, and north-western Queensland, 'may have an aquatic stage before flowering, with long-petiolate leaves with floating lamina'. An examination of the 136 sheets of this taxon in the Western Australian Herbarium (PERTH) found two sheets that unequivocally showed the presence of distinct aquatic leaves (PERTH 04806581, PERTH 05119766). A duplicate of the former collection in the National Herbarium of New South Wales (NSW 460174) also exhibits aquatic leaves (Pellow & Porter 2005). Several other sheets showed leaves intermediate between the aquatic form and the typical terrestrial form.

The recent description of *G. nocoleche* comprehensively documented the amphibious nature of that taxon (Pellow & Porter 2005). *Goodenia nocoleche* is restricted to a relatively confined area of seasonally inundated claypan basins in western New South Wales. It germinates in water up to 60 cm deep and produces floating leaves on greatly extended petioles. As the water drops plants grow rapidly, producing terrestrial leaves, then flowering and finally dying back as the wetland dries (Pellow & Porter 2005). Observations both in the glasshouse and field suggest this taxon is a summer annual.

In September 2010, a temporary freshwater wetland at the base of Ularring Rock in Western Australia was visited. This large granite inselberg occurs on the northern edge of the Coolgardie bioregion (Department of Sustainability, Environment, Water, Population and Communities 2004) and acts a major catchment area for the wetland (Figures 1, 2). The aquatic stage of an unidentified species of *Goodenia* was collected. Identification initially proved difficult due to a lack of sufficient fertile material. The wetland was revisited in the three subsequent years, which included one exceptionally wet year (2011) and one exceptionally dry year (2012) (Figure 2A, B).

This species was subsequently determined as a diminutive form of *G. berringbinensis* Carolin, which also belongs to sect. *Porphyranthus*. This population represents a 350 km range extension to the south-east from the main distribution area of the species in the Midwest covering parts of the Murchinson,

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ISSN 2200-2790 (Online)
ISSN 0085-4417 (Print)

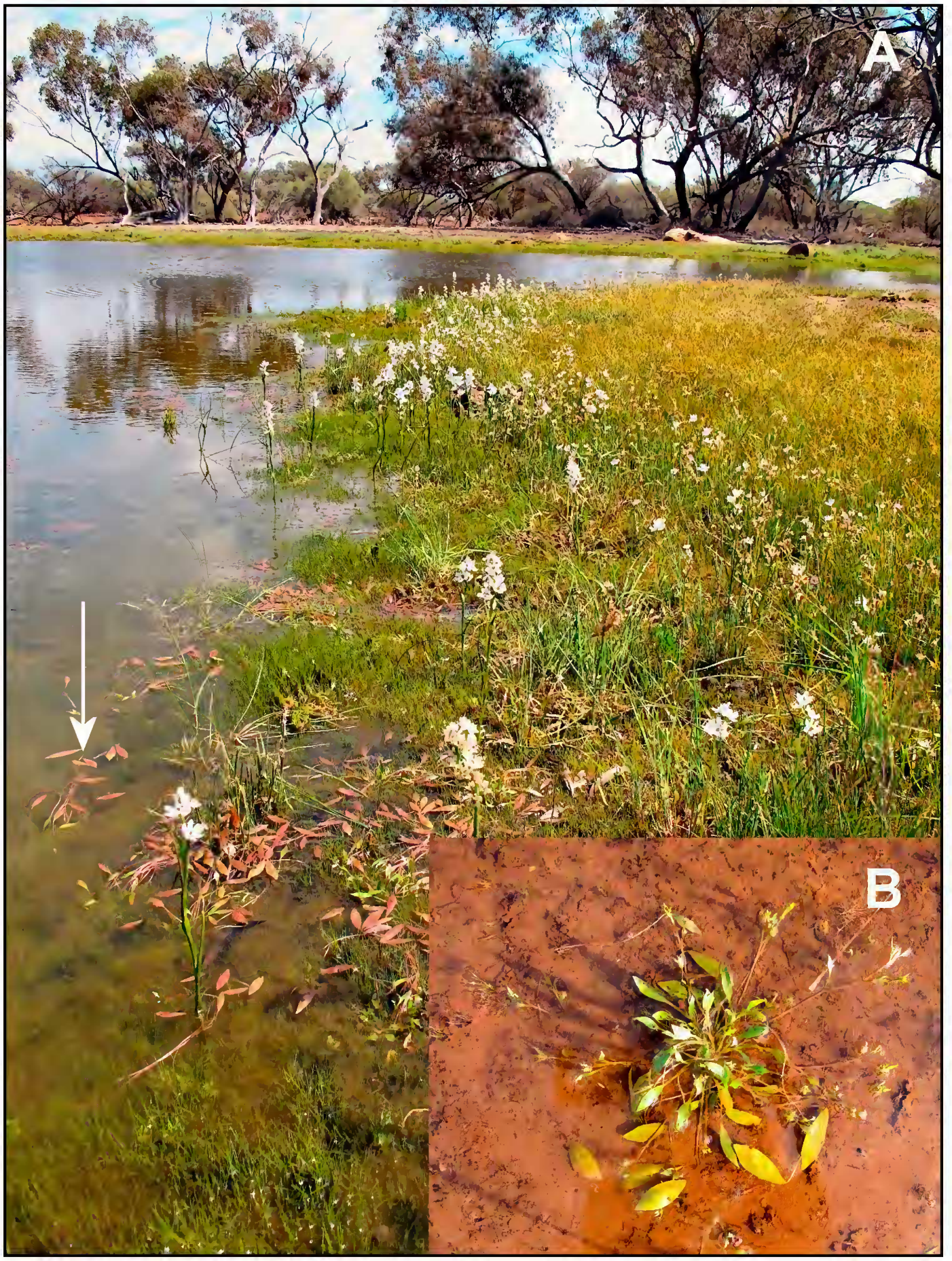

Figure 1. *Goodenia berringbinensis*. A – plants in aquatic phase *in situ* showing floating leaves (white arrow); B – as the wetland dries aquatic leaves are replaced by terrestrial leaves and flowering panicles are produced. Images: E.M. Sandiford (A); N. Gibson (B).

Gascoyne and Yalgoo bioregions (Figure 3). It differs from the typical form of the species in having consistently smaller flowers, and prostrate scapes to *c.* 15 cm long compared to ascending scapes to *c.* 30 cm. When described, *G. berringbinensis* was only known from two collections and was thought to have a very restricted distribution, being named from the type location at Berringbine Creek (Carolin 1990). Careful examination of the holotype (PERTH 01607197) reveals the presence of aquatic leaves

Figure 2. The ephemeral wetland north-west of Ularring Rock, Western Australia where *Goodenia berringbinensis* was found. A – the wetland was overflowing on 31 August 2011 following good seasonal rains. Dominant species *Wurmbea murchisoniana* with *G. berringbinensis* in the deeper pools in the distance; B – the following year (4 September 2012) was a poor season and the wetland did not fill. *Goodenia berringbinensis* was found on the floor and sides of the deeper basins, flowering without exhibiting the aquatic phase. Images: N. Gibson.

on the individual at the top of the sheet. The habit illustration of this species in *Flora of Australia* (Figure 47E, Carolin 1992) also shows what appear to be aquatic leaves citing *D. Goodall* 3275 (PERTH 02599945) as the collection on which it was based. However, it is likely that the illustration was based on the holotype as the Goodall collection has only mature fruiting individuals with no aquatic leaves.

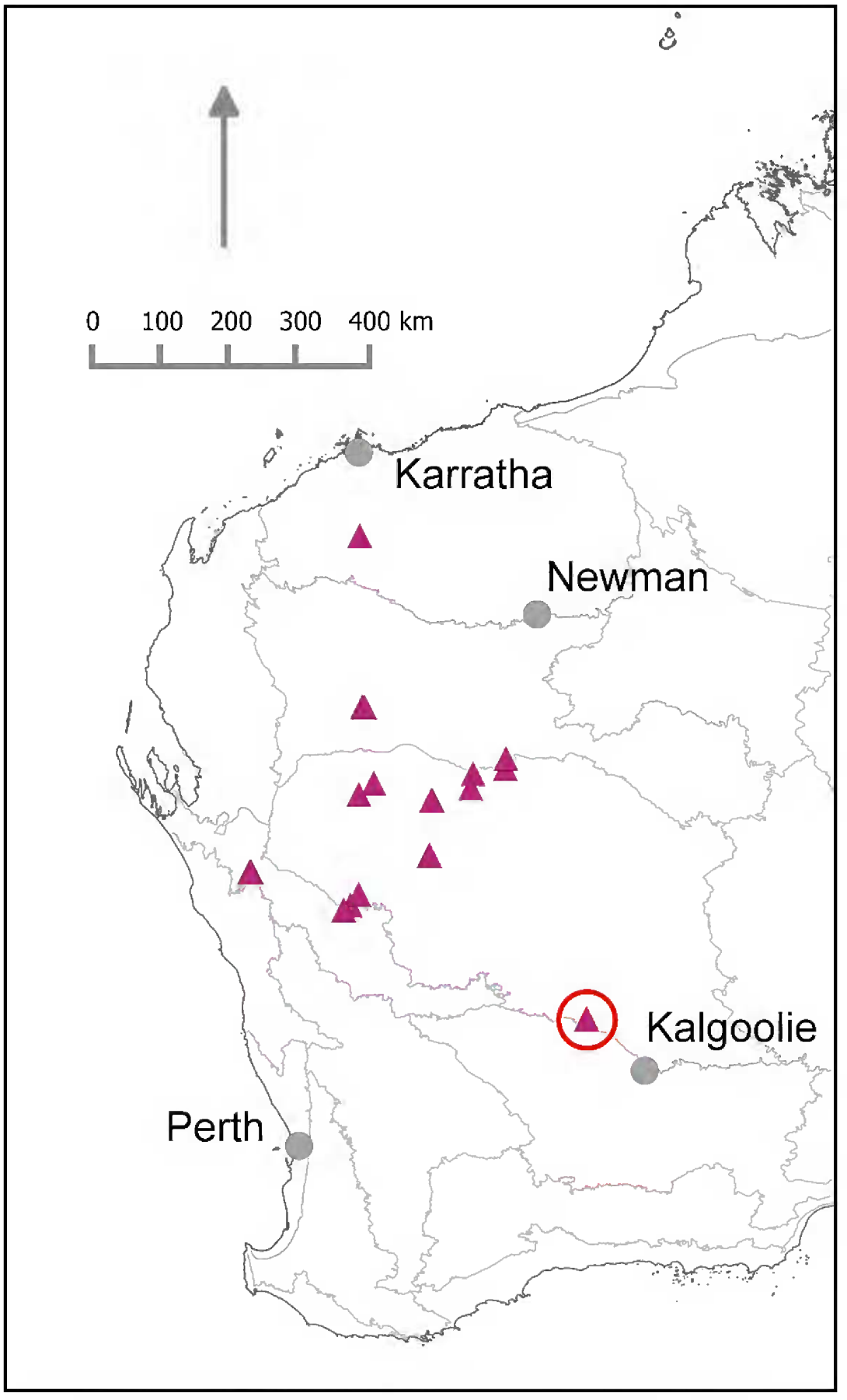

Figure 3. Distribution of *Goodenia berringbinensis* showing the disjunction between the main distribution and the more south-eastern population at the Ularring wetland (circled). The IBRA version 6.1 bioregions (Department of Sustainability, Environment, Water, Population and Communities 2004) are shown in grey.

The collections from 2010 (*N. Gibson & E.M. Sandiford* 4681) and 2011 (*N. Gibson & M. Langley* 4834) showed the presence of both aquatic and terrestrial leaves. In the dry year (2012), when the wetland did not fill, only terrestrial leaves were produced (*N. Gibson* 6432). In 2013, collections made from the deep (30 cm) water through the shallows to the drying wetland edge (*N. Gibson* 6450) showed all stages of the life cycle with the most floriferous individuals on the drying edge of the pool completely lacking aquatic leaves. The lack of aquatic leaves on herbarium collections

may therefore result either from their dying off before peak flowering or their absence in dry years when the wetlands did not fill. The rooting patterns of specimens from Ularring closely conform to Carolin's (1990) original description, with the presence of a thin taproot then a mass of adventitious roots. Carolin interpreted this as evidence for an annual life form. Field observations from the dry 2012 season clearly indicate the mature leaves die off as the season progresses. However, one collection (*N. Gibson & E.M. Sandiford* 4681) made in shallow water in 2010 had an old mature fruiting scape as well as aquatic leaves, young terrestrial leaves and very young scapes, suggesting this individual may be a geophyte that resprouted from its taproot.

While the Ularring wetland population is clearly allied to typical *G. berringbinensis*, its flower size is consistently smaller than all other collections of the species and the flowering scapes differ in being both smaller and prostrate compared to the typical form. Moreover, flower size does not show any major variation between wet and dry years. Further collections are needed in the 350 km disjunction between Ularring and the Midwest, where *G. berringbinensis* occurs widely (Figure 3), to clarify if this southern population should be recognised as a distinct taxon. For the present this entity is best considered as a distinct conservation unit within a more widely circumscribed taxon. Further surveys of ephemeral wetlands between Ularring Rock and the Midwest should be a priority. An updated circumscription based on Carolin (1990) incorporating the Ularring material is given below.

Goodenia berringbinensis Carolin, *Telopea* 3: 537–538 (1990). *Type*: Bed of Berringbine Creek, Belele Station, Western Australia, 15 October 1945, *C.A. Gardner* 7857 (*holo*: PERTH 01607197).

Villous and minutely glandular *herb* with a short and usually branched stock, with thin tap root and well developed adventitious root system. *Scapes* terete, generally ascending to 30 cm, occasionally prostrate to 15 cm. *Leaves* in flooded habitats elliptic, 30–50 mm long, 8–10 mm wide, floating on surface with petioles to 150–350 mm long, later terrestrial leaves mostly basal, spreading or ascending, oblanceolate to almost spathulate, (10–)35–60 mm long, 2–10 mm wide, tapering gradually into a distinct petiole to (10–)30 mm long with broad, scarious base obtuse, entire or with a few blunt teeth, villous-pubescent often ± glabrescent. *Flowers* in loose spreading terminal thyrses; bracts linear to elliptic, 4–15 mm long, 1–2 mm wide, entire; peduncles 5–30 mm long; bracteoles sometimes not exactly opposite, linear-elliptic, 3–4 mm long; pedicels (5–)13–20 mm long, articulate *c.* 1 mm below ovary, sometimes not obvious. *Sepals* lanceolate-elliptic, *c.* 3 mm long, 0.5 mm wide, adnate to ovary for ½–¾ its length. *Corolla* yellow with purplish auricles, *c.* (5–)12 mm long, villous-pubescent with long simple and minute glandular hairs outside, with some scattered simple hairs inside, auriculate; anterior pocket not prominent, ± as long as ovary; tube *c.* (1–)3 mm long; superior lobes narrow-oblong, (2.5–)8 mm long, (0.4–)0.8 mm wide; inferior lobes oblong, (2–)4–5 mm long, (0.6–)0.8 mm wide; wings to (1–)2 mm wide; connate part of inferior lobes (2–)5–6 mm long. *Stamen filament* *c.* (1.5–)3.5 mm long, *anthers* narrow-oblong, (0.5–)1.5 mm long. *Ovary* villous-pubescent; septum ⅔ as long as loculus; style (3–)7–8 mm long; indusium obtriangular, truncate at base, *c.* (0.7–)1.5 mm long, (0.8–)2 mm wide, convex, with almost straight orifice beset with white bristles (0.2–)0.3 mm long. *Fruit* ellipsoid to cylindrical (6–)7–8 mm long, sepals attached about half way, 2–valved to base, each valve entire. *Seeds* flat to biconvex, yellow-brown, elliptic, 0.8 mm long, smooth, glossy; wing *c.* 0.1 mm wide, mucilaginous.

Diagnostic features. Villous or minutely glandular, facultative amphibious herb producing floating lamina on long extended petioles under flooded conditions, thin tap root, sepals attached halfway along fruit.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 16 June 1968, *S.J.J. Davies s.n.* (PERTH); 21 June 1999, *R. Davis* 8893 B (PERTH); 8 July

2004, *D. Edinger* 4340 (PERTH); 4 Sep. 2012, *N. Gibson* 6432 (PERTH); 12 Sep. 2013, *N. Gibson* 6450 (PERTH); 31 Aug. 2011, *N. Gibson & M.A. Langley* 4834 (PERTH); 29 Sep. 2010, *N. Gibson & E.M. Sandiford* 4681 (PERTH); 30 Oct. 1965, *D.W. Goodall* 3275 (PERTH); 16 Oct. 2000, *F. Hort, A. Grosse & J. Hort* 1172 (MEL, PERTH); 5 Oct. 2004, *F. Hort, J. Hort & J. Shanks* 2270 (PERTH); 8 Oct. 2004, *F. Hort, J. Hort & J. Shanks* 2272 (NSW, PERTH).

Phenology. Flowering from June to October. Fruiting from September to October.

Distribution and habitat. Associated with ephemeral wetlands (granite or clay-based). Distributed in the western Murchison, Gascoyne and Yalgoo bioregions, with a northern occurrence on the Robe River in the Pilbara bioregion, and a southern outlier at Ularring Rock in the Coolgardie bioregion.

Conservation status. *Goodenia berringbinensis* is listed by Smith (2013) as Priority Four under Department of Parks and Wildlife Conservation Codes for Western Australian Flora.

Affinities. Allied to other annual species in sect. *Porphyranthus*, particularly *G. nocoleche*, which has glabrous vegetative parts, and *G. cylindrocarpa* Albr., which has a sparsely hairy ovary.

Acknowledgements

Fieldwork in 2011–2013 was funded by the Bush Blitz Program of the Australian Biological Resources Study.

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Neil Gibson

Science and Conservation Division, Department of Parks and Wildlife,
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983
Email: Neil.Gibson@dpaw.wa.gov.au